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Cavum Septi Pellucidi in Boxers

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Abstract

Objective: Controversy exists over the significance of the isolated finding of cavum septi pellucidi (CSP) and its prevalence rate in healthy individuals and in professional boxers. Few magnetic resonance imaging (MRI) studies have looked at large cohorts of boxers. The aim of this study was to identify the prevalence and extent of a CSP among professional boxers and to compare these with a control group.
Methods: MRI studies of 164 male boxers scanned for annual British boxing board license renewal were reviewed and compared with 43 control patients. CSP prevalence, size, and extent were recorded. Extent was classified as type 1, anterior to the fornix; type 2, extending up to the fornix; and type 3, extending into the cavum vergae. Parenchymal abnormalities were documented, and the Evan's ratio was used as an indication of brain atrophy.
Results: A CSP was present in 40% of controls and 49% of boxers. There was a trend to a higher CSP prevalence in boxers ($P = .099$). No control patient had type 2 or 3 extension ($P < .0009$), as opposed to 30% and 16% prevalence in boxers. Three boxers increased their extent over serial imaging. No difference in CSP size was established between the 2 groups ($P = .43$), but there was an association between progressive scans and increased CSP size over time in boxers, independent of age ($P = .05$). Eight boxers demonstrated a CSP on a subsequent scan not seen on an earlier scan.
Conclusion: The prevalence of a CSP is high among both control patients and boxers. There is a trend to a larger CSP with increasing number of scans without evidence of atrophy and independent of age. Boxers also have a greater posterior extent than controls. The findings may be explained by sudden increases in intracranial pressure that forced cerebrospinal fluid (CSF) through small defects in the septal leaflets, which result in an increase in size and or extent of a CSP.

Abrégé

Objectif: Il existe une controverse au sujet de l'importance de la découverte isolée d'un *cavum septum pellucidum* (CSP) et de son taux de prévalence chez les personnes en bonne santé et chez les boxeurs professionnels. Peu d'études d'imagerie par résonance magnétique (IRM) se sont penchées sur d'importantes cohortes de boxeurs. Cette étude avait pour but de déterminer la prévalence et l'étendue des CSP chez les boxeurs professionnels et de les comparer avec celles d'un groupe témoin.
Méthodes: Les études d'IRM de 164 boxeurs, tous des hommes, réalisées aux fins du renouvellement annuel de leur permis de boxe en Grande-Bretagne ont été examinées, puis comparées avec celles de 43 patients d'un groupe témoin. La prévalence, la taille et l'étendue des CSP ont été consignées. L'étendue était classée comme étant de type 1, antérieure au fornix, de type 2, s'étendant jusqu'au fornix, ou de type 3, s'étendant dans le *cavum vergae*. Les anomalies parenchymateuses ont été documentées et le rapport d'Evans a servi d'indicateur de l'atrophie cérébrale.
Résultats: Un CSP était présent chez 40 % des personnes du groupe témoin et chez 49 % des boxeurs. La prévalence de CSP tendait à être plus élevée chez les boxeurs ($P = 0{,}099$). Aucun patient du groupe témoin ne présentait une étendue de type 2 ou 3 ($P < 0{,}0009$), comparativement à une prévalence de 30 % et 16 % respectivement chez les boxeurs. L'imagerie sérielle a augmenté l'étendue chez trois boxeurs.

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Aucune différence de taille de CSP n'a été constatée entre les deux groupes ($P = 0,43$), mais un lien a été établi entre les analyses successives et une augmentation de la taille de CSP au fil du temps chez les boxeurs, sans tenir compte de l'âge ($P = 0,05$). Huit boxeurs présentaient sur une image ultérieure un CSP qui n'avait pas été décelé sur une image antérieure.

Conclusion: La prévalence de CSP est élevée chez les patients du groupe témoin et chez les boxeurs. Le CSP tend à augmenter avec le nombre d'images, sans preuve d'atrophie et sans tenir compte de l'âge. Les boxeurs présentent également une étendue postérieure plus grande que les personnes du groupe témoin. Les résultats peuvent s'expliquer par des augmentations soudaines de la pression intracrânienne qui poussent le liquide céphalorachidien dans de petites malformations des feuillets septaux, ce qui entraîne une augmentation de la taille et de l'étendue d'un CSP.

Key Words: Cavum pellucidi; Boxers; Head injury

Introduction

British professional boxers are required to undergo an annual magnetic resonance imaging (MRI) scan to maintain registration. The presence of a cavum septi pellucidi (CSP) is of uncertain and controversial significance [1,2]. A CSP has been cited as a marker of previous head injury in these and other athletes engaged in sports that involve heavy physical contact [3–5]. The prevalence of CSP on MRI among the general population is unknown, although neuropathology and radiographic (pneumoencephalography, computed tomography [CT], and limited MRI) imaging data exist, with a prevalence of 0.7%–60% [6–15]. These studies documented the presence of a CSP, and we are unaware of any previous study that looked at the degree of posterior extent. Debate as to whether there is a higher prevalence in boxers continues, and whether these professional sportsmen should be allowed to continue boxing if a CSP is present. We evaluated the MRI studies of 164 alphabetically consecutive boxers and compared them with a small control cohort to document the prevalence, extent, and size of CSP on MRI in each group.

Methods

A total of 164 consecutive boxers studies held by the British boxing board at The London Imaging Centre, Harley Street, were compared with a sex-matched cohort of control patients from a teaching hospital who had normal MRI studies in the context of minor symptoms. A history of head injury or contact sport was excluded on questioning. Our study was powered to detect a difference in prevalence of CSP between boxers and controls of more than 20%. The presence, absence, size, and extent of a CSP were evaluated, in addition to any parenchymal abnormality and the Evan's ratio. Coronal T1 images (TR/TE 600/20, ST/interslice gap 5 mm/1 mm) were best suited for confirming the presence of CSP. The extent was assessed on axial T2-weighted images (TR/TE 2,000/100, ST/interslice gap 5 mm/1 mm) and divided into 3 types: type 1 was anterior to the fornix, type 2 extended up to the fornix, and type 3 extended into the cavum vergae. Prevalence was compared with the χ^2 test, and extent was compared with the Fisher exact test. Values were adjusted for age difference between the control and boxers groups. Mathematical modeling was performed to take into account multiple measurements.

Results

There were 207 subjects, of whom 164 were boxers with a total of 314 studies. The majority of boxers had a single study (52%) or 2 studies (33.5%). Twenty-one boxers had 3 scans (13%), 2 boxers had 4 scans (1%), and a single subject had 5 studies (0.5%). The time interval between the first and second studies was a mean (standard deviation [SD]) of 429 ± 125 days and between the second and the third studies was 761 ± 178 days. The mean (SD) age of controls (31 ± 5.95 years) was higher than that of the boxers (26 ± 4.12 years) ($P < .0001$). All data analysis was adjusted for this difference in age.

A CSP was present in 150 of 314 studies accounted for by 40% of controls (17/43) and 49% of boxers (81/164). When comparing the final scan of each boxer with the control group, there was a trend to a higher CSP prevalence, with 89% higher odds ($P = .09$). The mean size of a CSP was compared between the 2 groups and showed no significant difference between boxers and controls, although there was a trend to being 0.23 mm larger ($P = .43$) in boxers. Within the CSP-positive boxers and controls, age did not influence the prevalence of a CSP, but an increased number of studies, which reflected a longer boxing career, showed a trend towards a larger CSP among boxers ($P = .05$). Eight boxers demonstrated a CSP on a subsequent scan not seen on an earlier scan (Figure 1). The CSP extent was significantly different (independent of age) in the 2 groups, with no control patients having type 2 or 3 extension ($P < .0009$). In contrast, 30% and 16% of the boxers had a type 2 and 3 extension, respectively. Three boxers increased their extent over serial imaging: 2 increased from type 1 to type 2, and one increased from type 2 to type 3. The Evan's ratio was not higher in boxers compared with controls. No abnormal parenchymal lesions were present in any boxer or control.

Discussion

We demonstrated a trend towards a greater CSP prevalence with a tendency to increased size at first scan in boxers

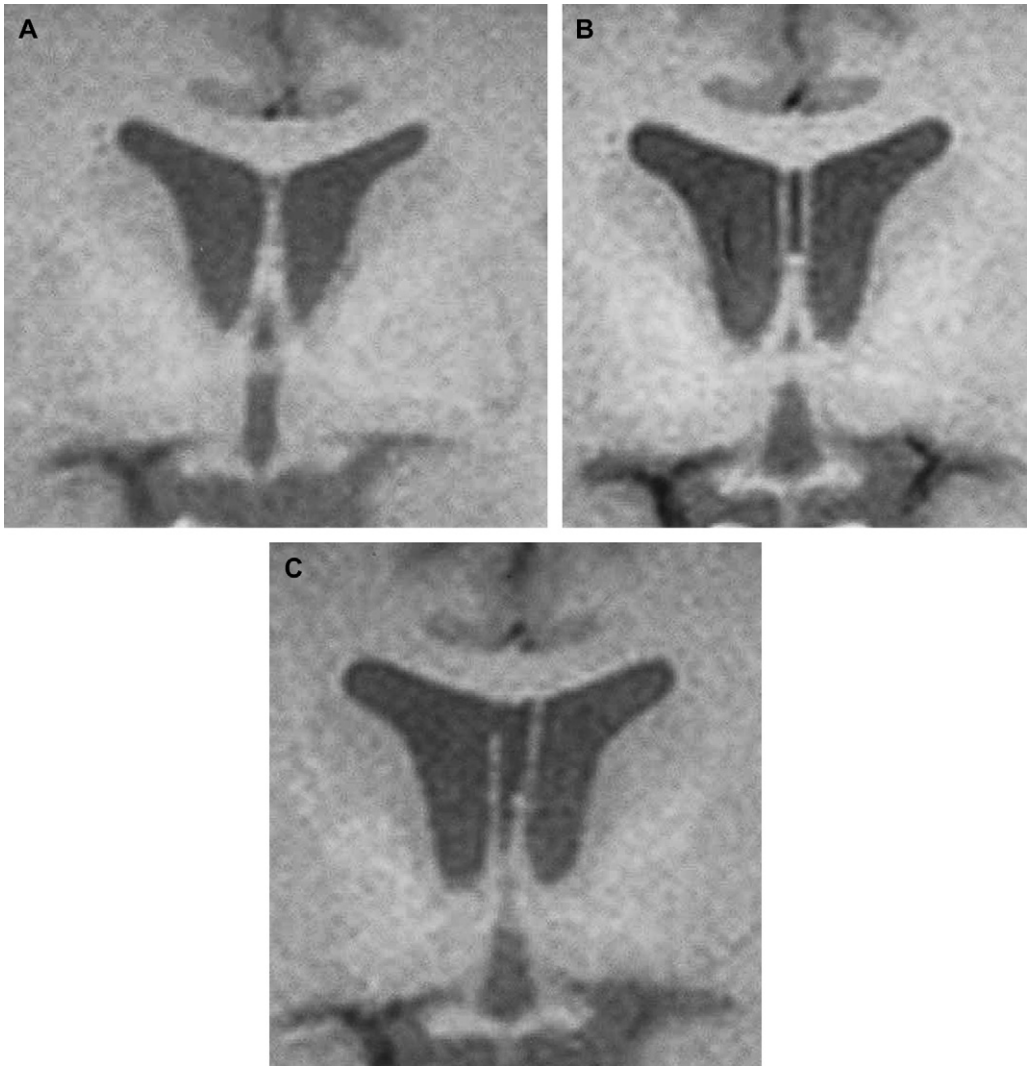

Figure 1. Serial coronal T1 W MRI at the level of the chiasm. (A) The initial study, dated January 29, 2000, revealed a normal study. (B) Two years later (April 29, 2002), CSP had developed. (C) One year later (May 15, 2003), the right leaflet of cavum had perforated.

compared with controls. The CSP showed a stronger trend to increase size over time. There is a significant association with a greater posterior extent, independent of age. The findings confirm a higher prevalence of CSP in the general population on imaging than reported in early neuropathology studies [7,15] but in agreement with other reported studies [6−14] and likely reflects the greater sensitivity of MRI as a technique for detecting the abnormality of the CSP [11]. We did not demonstrate a significant increased prevalence in boxers, which added to the growing body of evidence that this structure may not be more prevalent in this group. The study was powered to detect a difference of 20%, which was derived from the difference in prevalence between pathologic and radiologic series. If the difference in prevalence is smaller, then we would have insufficient power to detect these changes. However, we did demonstrate 8 boxers in whom a CSP was not present on an earlier scan who subsequently demonstrated this finding (Figure 1). Two of these had a CSP that measured on average 2.5 mm, and the remaining 6 had a CSP that measured 1−1.5 mm on follow-up imaging. One patient demonstrated a tear in septal leaflets 2.5 years after the initial normal study (Figure 1). It is unlikely that the CSP was missed because of partial volume averaging, because both coronal T1-weighted and axial T2-weighted images were available for review. This suggests that, although prevalent in a healthy population, a CSP may also be an acquired entity, with head trauma as a possible etiology. Whether this is also true of the control population cannot be answered by this study, because none has multiple studies.

Although there was a trend to a larger size CSP in boxers than controls that also increased with time, there was no correlation with an increased Evan's index. This does not support the theory that enlarging ventricles caused by atrophy result in separation of the septal leaflets and enlargement of the CSP [7,16]. As far as we are aware, no previous study has systematically looked at the posterior extent of CSP in boxers but rather noted its presence or

absence. One study documented the prevalence of a cavum vergae in 1000 adult patients undergoing head CT and found a prevalence of 0.5% [9]. The prevalence was found to be higher in children undergoing CT (5%) [17] and in an autopsy series (2.3%) [6]. We report a more posterior extent in boxers than in the control group, with a higher prevalence of cavum vergae than reported in normal children or adults. In addition, 3 boxers increased the posterior extent of their CSP. The findings lend support to a previous hypothesis that the septal leaflets may be separated when a tear permits the ingress of cerebrospinal fluid (CSF), and which then facilitates growth of the CSP [18]. This explanation may also explain why no increased atrophy was found among boxers, yet the CSP showed a tendency to be larger and increase over time. We cannot, however, discount a random selection bias among the control group, despite their consecutive selection, which accounted for a lack of type 2 and 3 CSP subtypes. In addition, a cavum vergae may be found with other midline abnormalities and is not an independent marker of head injury [19]. A larger control cohort may answer this question more fully.

A limitation of this study was the absence of information regarding the duration of boxing, number of bouts, knockouts, and concomitant head injury. It would be interesting to compare the boxing careers of the 8 boxers with CSP development and the 3 with extent alteration with those who were static. No gradient T2 imaging, diffusion imaging, or spectroscopy was performed on these patients, although some of these sequences may have merit in this context [20,21]. Ideally, a control group should comprise healthy volunteers, however, the choice of patients undergoing MRI for minor symptoms with normal MRI studies was the best comparison sample available. The ages of the control and boxers were significantly different, which reflected the difficulty we had in recruiting young control patients. The control group was older, and any bias regarding CSP prevalence should have been in favor of controls rather than boxers. In addition, age was controlled for in all statistical analysis.

Conclusion

We demonstrated a high prevalence of CSP among a control group and boxers. Boxers demonstrated a greater posterior extent than controls. Although the CSP was not larger between controls and boxers, there was a trend to increased size with progressive number of scans in the absence of atrophy. It may be postulated that sudden increases in intracranial pressure result in passage of CSF through small defects and/or tears in the septal leaflets and cause an existing CSP to increase in size and/or extent. Perhaps tears may occur in unseparated leaflets also, which explains development of a CSP in the 8 boxers with previously normal scans.

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